Facial Emotion Recognition Project
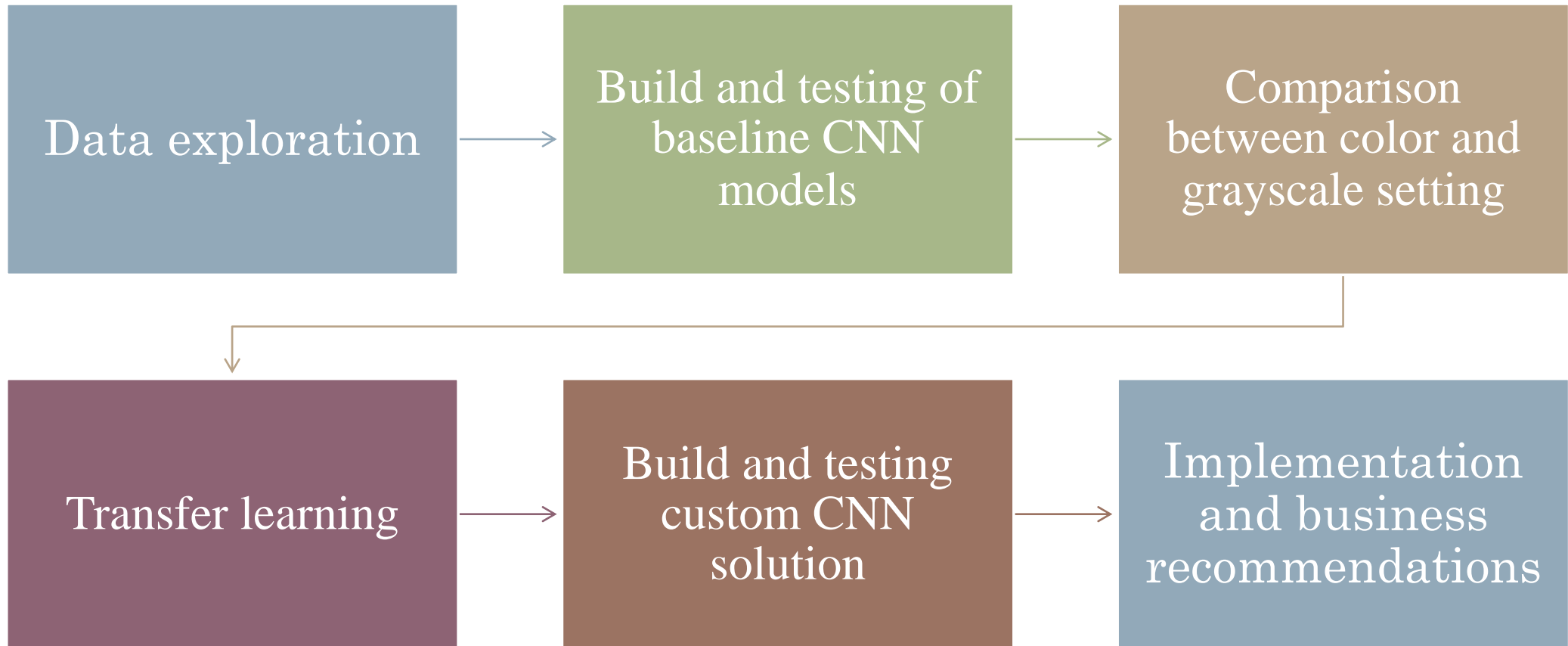
- Marco Defilippi
- MIT Applied Data Science Program
- April 2024

Problem description

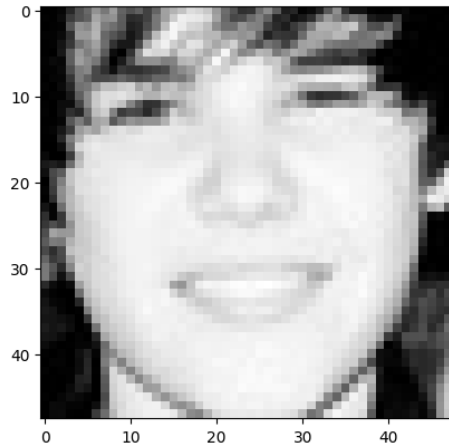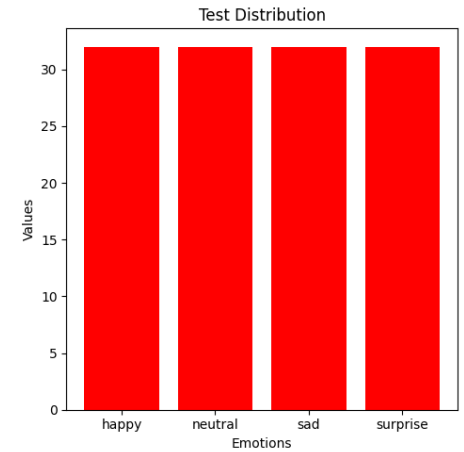|	
Facial Emotion	Vital in human interactions. Increasingly significant in many fields, e.g., diagnostic and social robotics. Around 55% of sentiments takes place through facial emotions.
Finding Solutions	Evolving from baseline to advanced models. Prioritizing neural networks for classification. Balancing hardware limitations and efficiency. Extensive testing across different model architectures.
Project Objective	Address class distinction challenges. Evaluate the model's generalization and reliability. Acknowledge and manage potential risks.

Workflow analysis

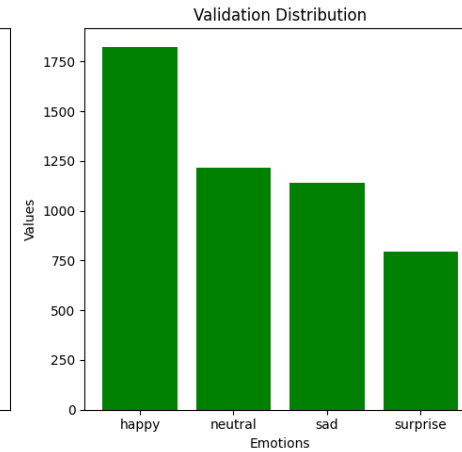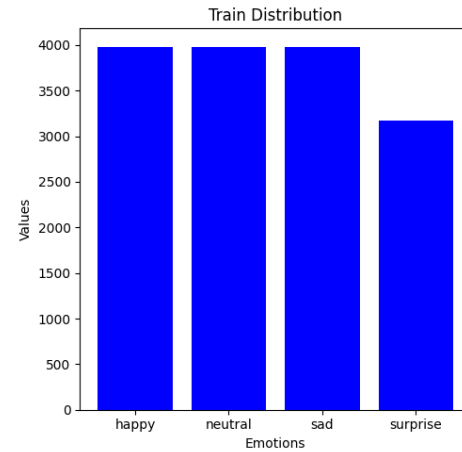|		
Data exploration	Build and testing of baseline CNN models	Comparison between color and grayscale setting
Transfer learning	Build and testing custom CNN solution	Implementation and business recommendations

Data Exploration

Image size: 48x48 pixel
Grayscale colour

Class	Train dataset	Validation dataset	Test dataset
Happy	3976	1825	32
Sad	3978	1216	32
Neutral	3982	1139	32
Surprise	3173	797	32
Total Nbr of Images	**15109**	**4977**	**128**

Comparative Analysis of CNN Baseline Models: Accuracy for RGB vs Grayscale Image Inputs
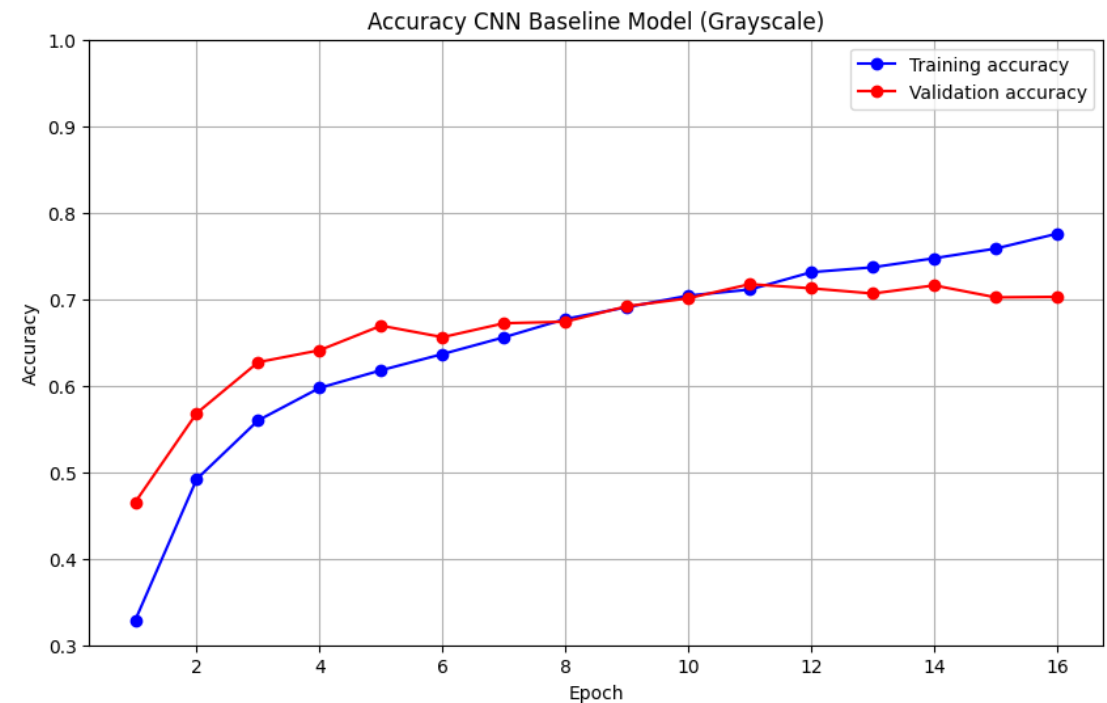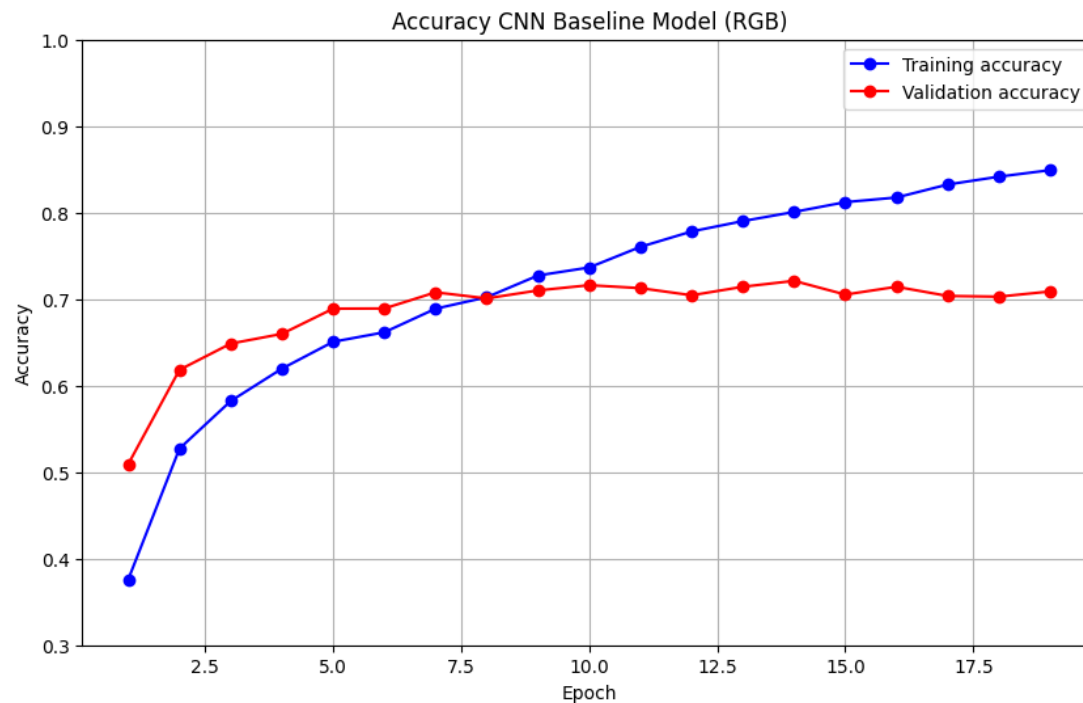
Evaluating Performance: Baseline CNN vs Large-Scale CNN Models

Accuracy CNN Baseline Model (Grayscale)

Accuracy Baseline Model (Grayscale)
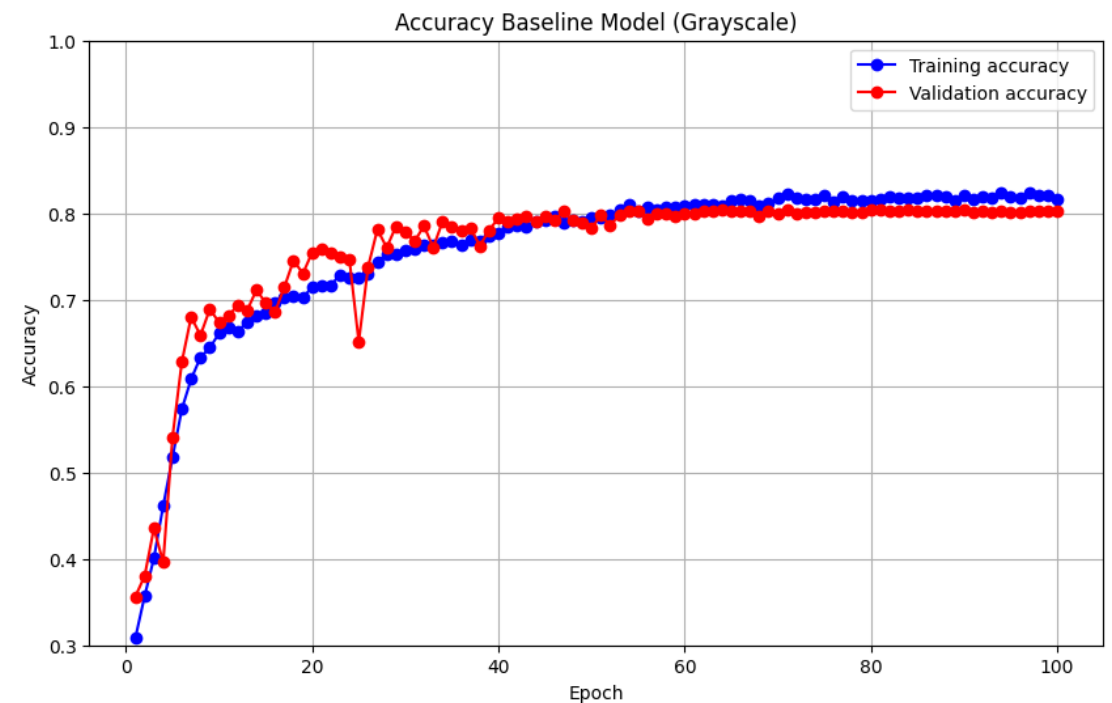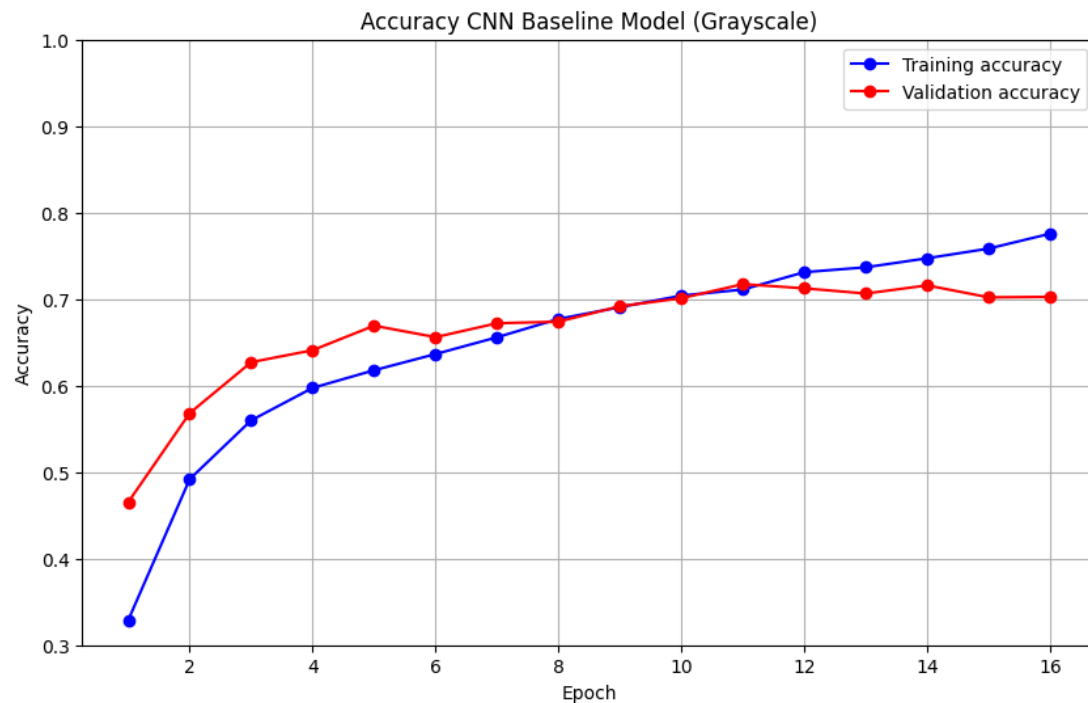
- Added convolutional layers
- Data augmentation

Evaluating Performance Across Different Transfer Learning Models

Comparison of Validation Accuracies for Different Models
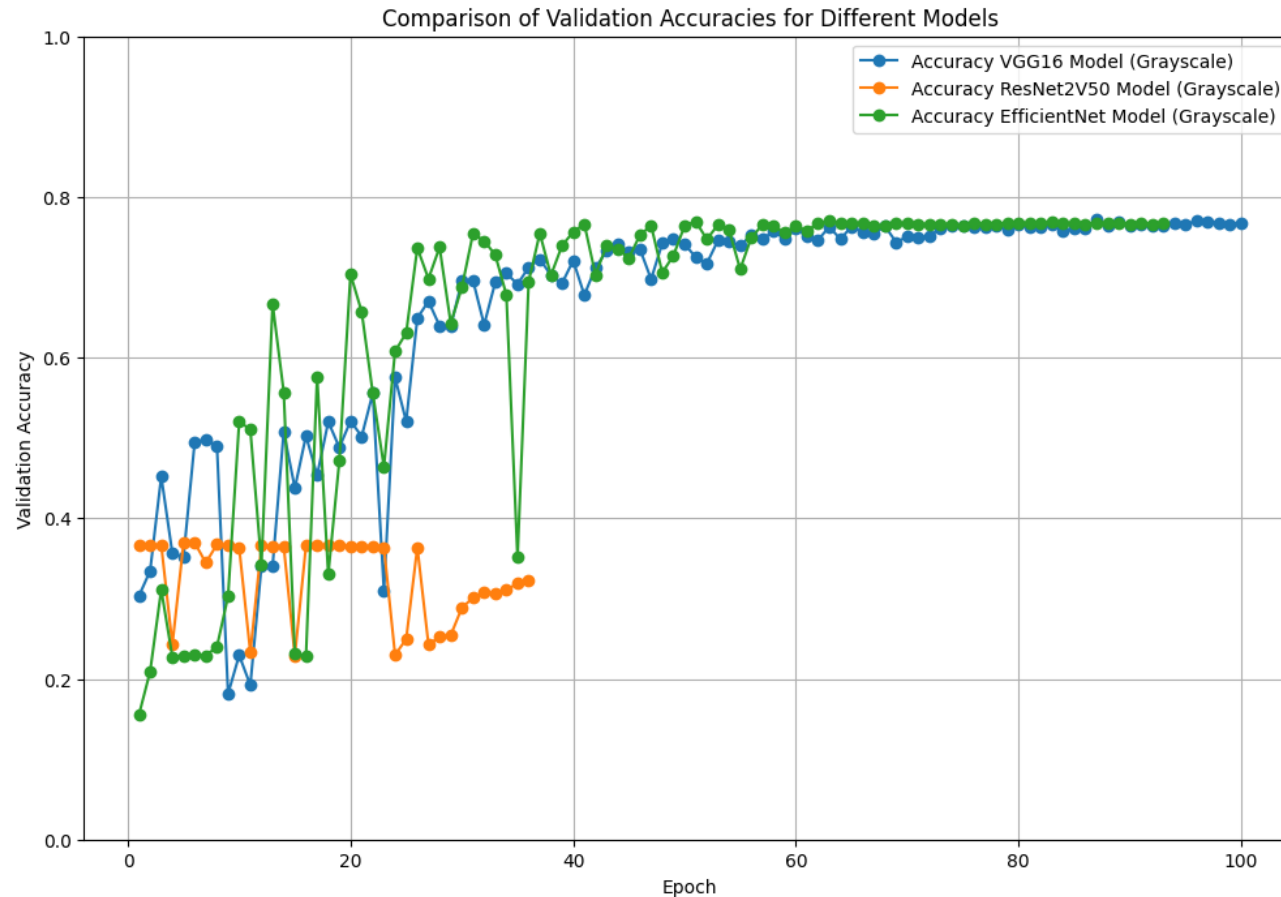
Evaluating Performance: Custom CNN model

Comparison of Validation Accuracies for Different Models
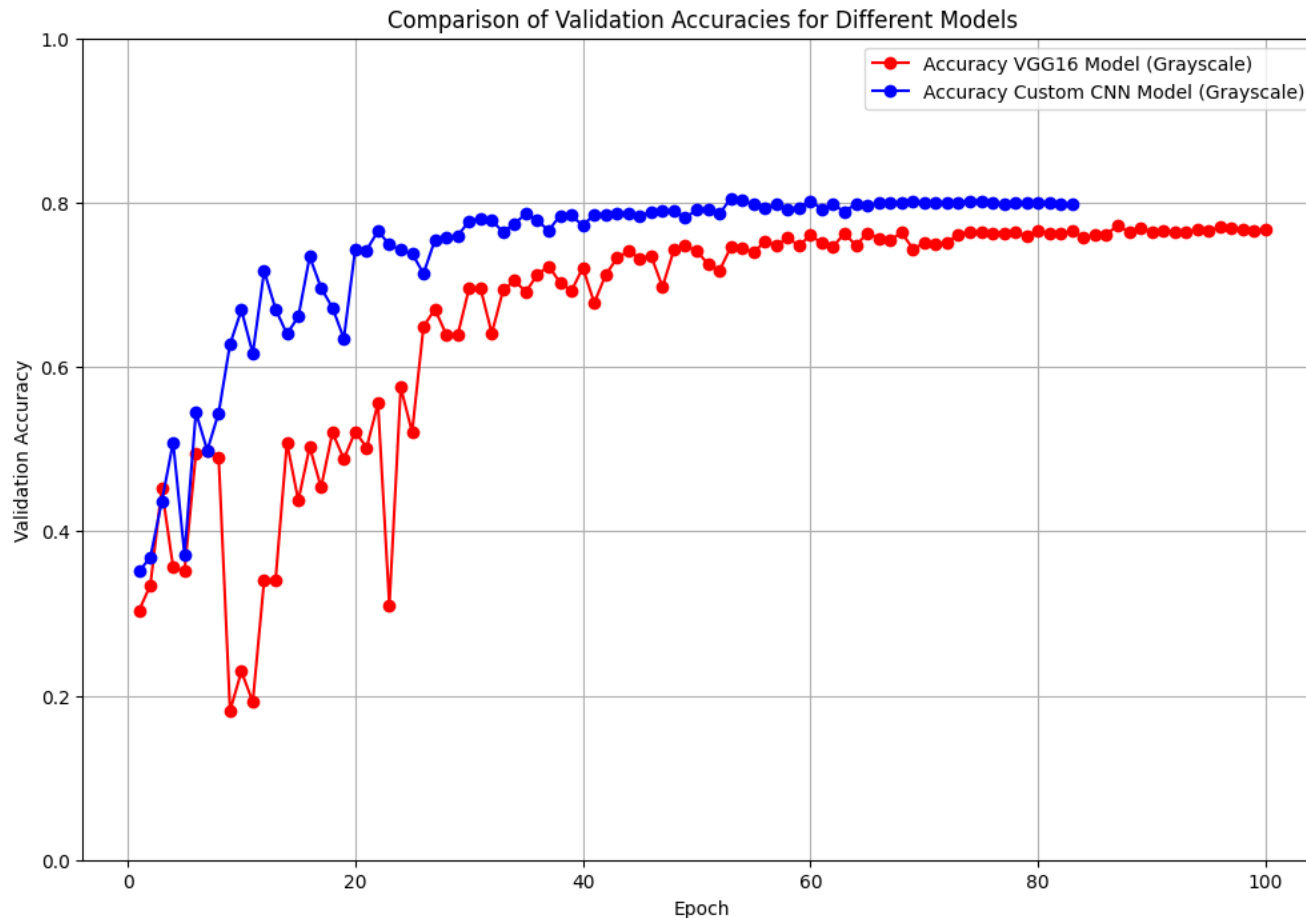
Custom CNN model:

- 8 sets convolutional layers.
- BatchNormalization, pooling and dropout layers.
- Number of filters increases in each set, capturing hierarchical features.
- Total params: 5,941,444 comparable to VGG16

- Custom CNN model as final solution!

Custom CNN model: In-depth Performance Evaluation
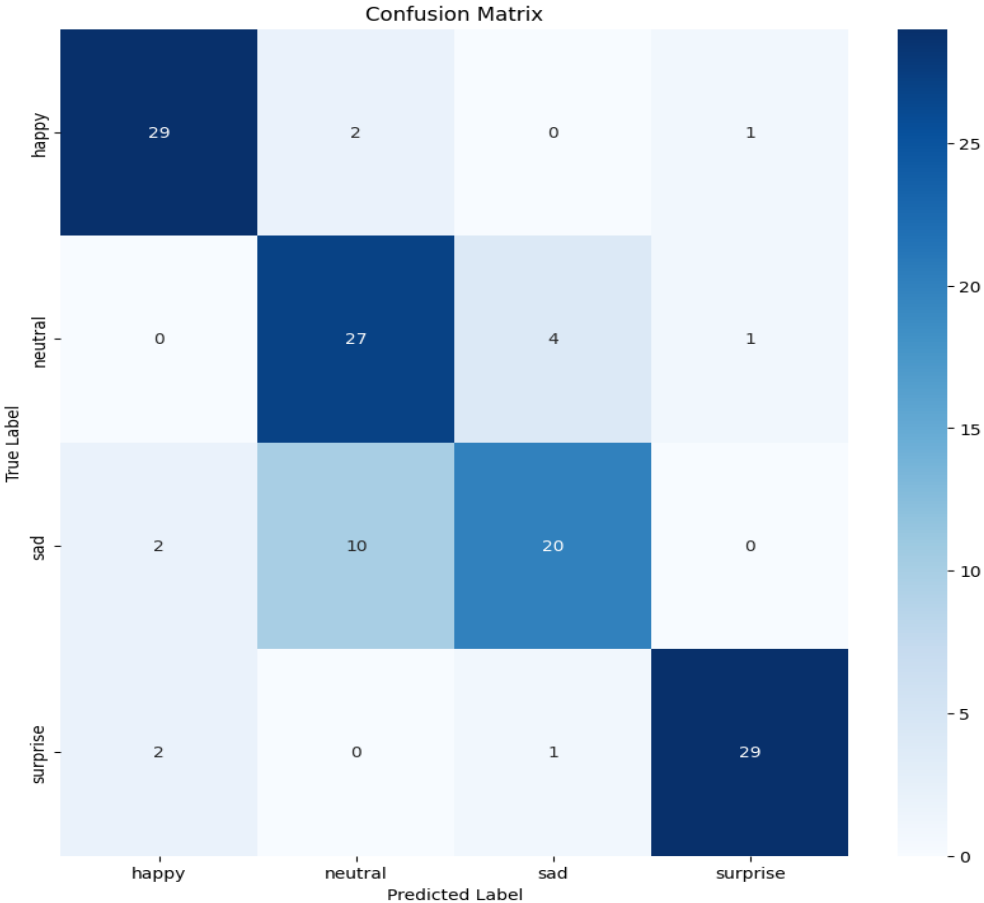
Confusion Matrix

Class	Precision	Recall	F1-Score	Support
Happy	0.88	0.91	0.89	32
Sad	0.8	0.62	0.70	32
Neutral	0.69	0.84	0.76	32
Surprise	0.94	0.91	0.92	32
Accuracy			**0.82**	128
Macro Avg	0.83	0.82	0.82	128
Weighted Avg	0.83	0.82	0.82	128

Classification Report

Implementation Recommendations

Proposed model solution	Specialized and adaptable solution. Balancing between performance and operational constraints (real-time application, mobile application, etc.)
Ideas for improvements	Integration of additional information, in-depth studies on the variability of emotional expressions across different cultures .
Future Steps	Integration into end-user applications, user feedback on the model's accuracy and usefulness, correct privacy management
Risks and challenges.	Careful management of privacy, ethical considerations in sensitive settings such as healthcare and education.

Expected Benefits and Costs for Business
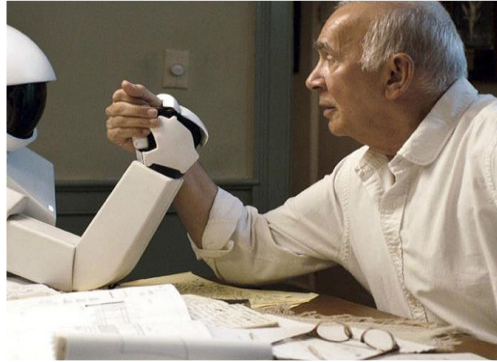
Benefits

Enhanced interactivity and personalization of user interfaces.

Healthcare, safety monitoring, live customer interactions, social robotics.

Costs

Data acquisition, software development tools, technical staff.

Hardware, maintenance, data storage, security updates.
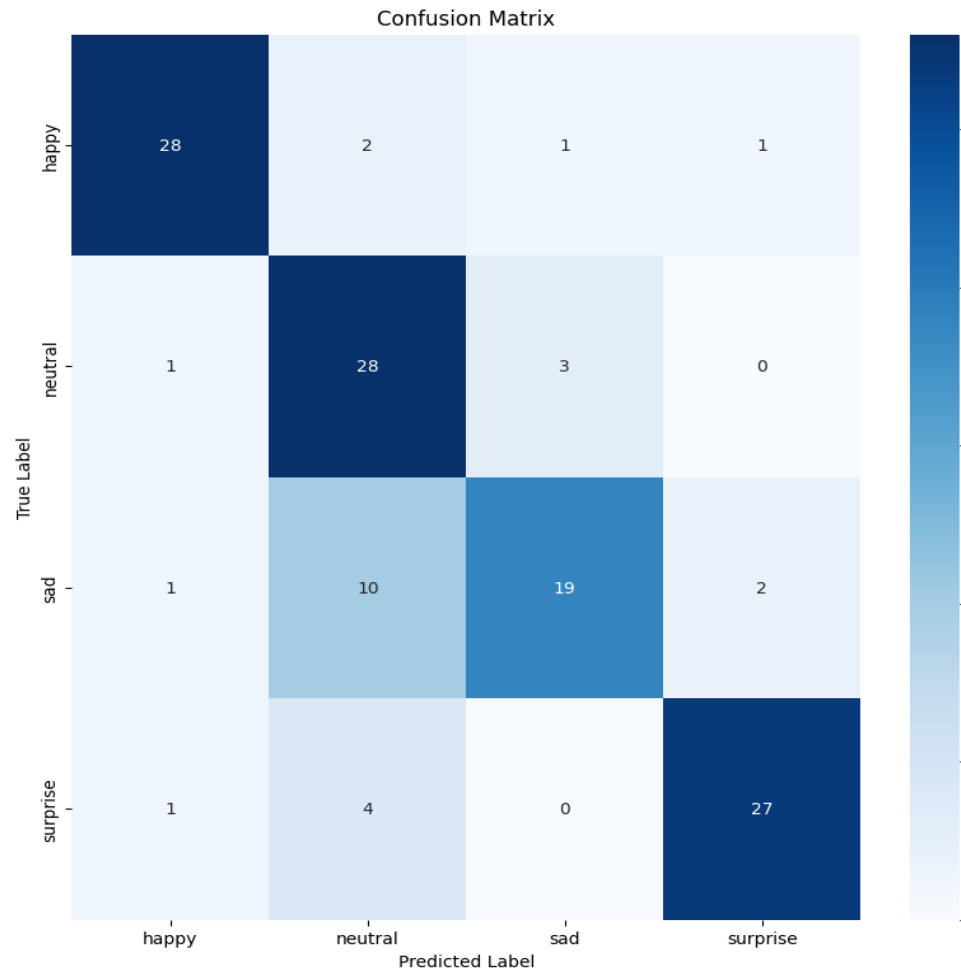
Improvements based on user feedback.

Thank You!

APPENDIX

CNN Models Comparison

CNN Model	Total Params	Accuracy
Baseline CNN	388,484	0.69
Larger CNN	2,395,204	0.79
VGG16	14,714,688	0.79
ResNet50V2	25,613,800	0.46
EfficientNet	5,330,571	0.78
Custom CNN	5,941,444	0.82

VGG16 Model In-Depth Performance

Confusion Matrix

Class	Precision	Recall	F1-Score	Support
Happy	0.90	0.88	0.89	32
Sad	0.83	0.59	0.69	32
Neutral	0.64	0.88	0.74	32
Surprise	0.90	0.84	0.97	32
Accuracy			**0.80**	128
Macro Avg	0.82	0.80	0.80	128
Weighted Avg	0.82	0.80	0.80	128